Vol. 11, No. 2. June, 1954.

THE QUEENSLAND JOURNAL OF AGRICULTURAL SCIENCE

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PUBLISHED QUARTERLY

By the Queensland Department of Agriculture and Stock, Brisbane

Issued by Direction of Hon H. H. COLLINS,
Secretary for Agriculture and Stock.

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THE QUEENSLAND JOURNAL OF AGRICULTURAL SCIENCE

Vol. 11. - - No. 2.

JUNE, 1954.

A STUDY OF LIVEWEIGHT INCREMENTS IN EWES AND OF CARCASS QUALITY AND MATURITY RATES IN LAMBS GROWN ON SOWN PASTURES IN SOUTH-EASTERN QUEENSLAND.

By N. W. BRITON, B.V.Sc. (Principal, Queensland Agricultural High School and College, Lawes), and T. B. PALTRIDGE, B.Sc. (Principal Research Officer, C.S.I.R.O. Plant and Soils Laboratory, Brisbane).

SUMMARY.

This paper records animal data from an experiment in which lambing ewes were used to measure the quality of feed and the carrying capacity of sown pastures in south-eastern Queensland.

The use of different pastures over two years, with contrasting seasonal conditions, gave varying rates of growth amongst the lambs. The quality of lamb carcasses was assessed by means of a block test to determine the inter-relationship of age at maturity and carcass quality.

The experiment compared four pastures, viz., (1) lucerne (Medicago sativa), **(2) a perennial grass** (Paspalum scrobiculatum), **(3) a mixture of lucerne and** P. scrobiculatum, **and (4) a mixture of** P. scrobiculatum **and the annual legume** Phaseolus lathyroides.

Each of these four pastures was used to carry a separate flock of ewes comprising (a) dry ewes, (b) ewes with one lamb, and (c) ewes with twin lambs, in varying proportions. The data show that in all cases highest weight gains were recorded on lucerne pastures, but the quantity of feed was not sufficient to maintain a standard flock during all months of the year.

On pastures of P. scrobiculatum **and on the mixture** P. scrobiculatum **and** Phaseolus **the quantity of feed was sufficient, but the quality was sub-optimal for lambing ewes in late winter and early spring.**

Mixed pastures of P. scrobiculatum **and lucerne provided adequate feed of near-optimal quality during all months of the year, but this pasture was more difficult to maintain.**

On lucerne pastures, lambs (both singles and twins) were matured in less than 90 days, and they produced first quality carcasses. On P. scrobiculatum**—alone and in combination with** Phaseolus**—the lambs matured more slowly and produced less satisfactory carcasses. The mixture of** P. scrobiculatum **and lucerne was satisfactory for all but twin lambs in 1949.**

Over all treatments there was a close correlation between the quality of lamb carcasses and their age at maturity, with best quality carcasses from lambs matured within 90 days.

I. INTRODUCTION.

In a separate paper one of the authors (Paltridge 1954) has described a number of experiments, each of which is part of a wider study aiming at the development of sown pastures for south-eastern Queensland. This paper records animal data from one of those experiments in which lambing ewes were used to measure the quality of feed and the carrying capacity of selected pastures.

The data were recorded over a period of approximately two years (October 1948—January 1951) with marked differences in the incidence and intensity of rainfall. In 1949 the main growing season was delayed until late February and March, and there was comparatively little growth of summer-growing pasture plants. The winter months were unusually dry with strong drying winds in July and August. In 1950 there was an abundance of feed produced after heavy rains in January and February, the first frosts were delayed until June, and there were unusual flood rains in late June and July (see Table 1).

Table 1.

RAINFALL AT LAWES (IN INCHES) DURING 1949 AND 1950.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug..	Sep.	Oct.	Nov.	Dec.	Total.
1949 ..	1·29	6·18	5·10	·21	·33	2·07	·96	·82	2·04	6·79	1·46	1·68	28·93
1950 ..	7·83	10·79	2·22	2·60	·43	6·00	5·97	·55	·11	6·08	4·55	1·73	48·86
Mean N=43	4·40	3·36	3·34	1·84	1·54	1·73	1·37	1·06	1·44	1·99	2·89	3·72	28·68

II. DESIGN OF EXPERIMENT.

(*a*) General.

The experiment was designed as a latin square with four blocks and four pastures, viz.,

(1) Lucerne (alone).

(2) *Paspalum scrobiculatum* (alone).

(3) *P. scrobiculatum* + lucerne.

(4) *P. scrobiculatum* + *Phaseolus lathyroides* (annual legume).

In each treatment the pastures were subdivided at random into three subplots planted respectively as a sward and in rows at 42 in. and 63 in. spacing. Individual subplots were separately fenced, and each of the resultant 12 pastures was used to maintain a standard flock of Border Leicester x Merino crossbred ewes.

The sheep were grazed on each block for periods of a fortnight in rotation, and in moving from one block to another individual flocks were maintained exclusively on one type of pasture.

The experiment commenced in October 1948 with a standard flock of nine ewes per treatment (subplot)—equivalent to 3·20 sheep per acre—but by the end of April 1949 it was apparent that some pastures were being overgrazed, and thereafter the numbers were varied to suit seasonal conditions and the quantity of available feed. Excess animals were held in separate paddocks in which those from any one treatment could be maintained on essentially similar pastures.

Individual treatments (subplots) were sampled immediately before each period of grazing, and sub-samples were set aside for subsequent chemical analysis. There were appreciable differences in the yield and vigour of pastures under the three spacing treatments (see Paltridge 1954), but these were not reflected in the animals concerned; therefore in this paper the data from animals on individual subplots have been combined to allow overall comparison of animals on each of the four major pastures.

(*b*) Selection and Allocation of Ewes and Rams.

The choice of Border Leicester x Merino crossbred ewes for this experiment followed preliminary investigation by Briton (1952) in which a number of breed combinations were used to determine the most suitable type of sheep for fat-lamb raising in this environment. In those experiments a number of flocks, comprising (1) Border Leicester x Merino, (2) Romney Marsh x Merino, and (3) Corriedale ewes, were used, each mated with Southdown, Dorset Horn, and Ryland rams. This was primarily a study of genetic values, and in order to provide optimum nutrition all sheep were held, and lambs matured, on irrigated pastures of oats and lucerne. The lambs were slaughtered at a paddock weight of 63 lb.; birth weights and maturity rates were recorded and, as a basis of appraisal, all carcasses were subjected to a modified block test. Under these conditions and using satisfactory breed combinations, high quality carcasses were obtained from lambs matured in approximately 10 weeks (8–11 weeks.)

General vigour and/or milk production in Border Leicester crossbred ewes were appreciably greater than in other breeds, and ewe numbers were maintained over a period of years, whereas an appreciable number of deaths occurred in both Romney Marsh x Merino crossbreeds and Corriedales.

The percentage of lambs from Dorset Horn and Southdown rams was satisfactory (with matings at times dictated by Queensland conditions), but very few lambs were born of Ryland male parents. Lambs produced by Southdown sires yielded a higher percentage of high-grade carcasses, but those produced by Dorset Horn sires had an advantage in earlier maturity to the extent of one or two weeks. In this experiment, therefore, Southdown and Dorset Horn rams were used in alternate years. All rams were subjected to a preliminary semen test before mating.

At the commencement of each season (i.e., in October 1948 and in December 1949) all ewes were graded according to weight and divided into nine groups, each of 13 animals. One sheep from each weight group was then

included in each of the 12 flocks to be used on individual treatments. The 10 animals in each flock were then re-graded according to conformation, and one (the most atypical) was removed and held as a "reserve" for the particular treatment. The 12 reserve animals were held in separate paddocks, except during mating, when they were added to the main flock for a period of approximately eight weeks.

The ewes were weighed each fortnight (except during lambing, when any unnecessary handling was avoided), and all lambs were weighed at birth and thereafter on the same day of each week.

(*c*) Mating.

During the 1949 season mating commenced on January 25, and Dorset Horn rams were used. At that time it was found that a number of the rams were comparatively infertile; in an attempt to avoid uneven lambing the more fertile animals were allocated at random, and each ram moved from one group of ewes to the next at weekly intervals. In 1950 mating commenced on April 11 and Southdown rams were used. All but two were highly fertile, but the same procedure was followed (i.e., weekly transfer of individual rams from one flock of ewes to the next).

The 1949 mating was comparatively early, and lambs were born in winter when the grass *P. scrobiculatum* was mature and heavily frosted. In 1950 a later mating delayed lambing until September, when this grass was making new growth and the pasture as a whole was richer in protein.

III. RESULTS.

(*a*) Ewe Weights.

(i) *Data for 1949.*—During the first two months of the experiment the mean weight of ewes on all four pastures rose steeply to a common value of approximately 126 lb. Thereafter they remained practically stable until June 14. From that date (i.e., from the commencement of lambing) there were obvious differences in weights recorded for "dry ewes" and for "ewes with lamb", and the 21 animals on each pasture (inclusive of three spacing treatments) were then subdivided as—

(1) Dry ewes.

(2) Ewes with a single lamb.

(3) Ewes with twins*.

Data appropriate to each class were separately recorded.

Ten weeks later (i.e., on August 23, 1949, when the animals were shorn), it was apparent that all ewes had lost weight, but whereas the mean weight for dry ewes had declined by only 3 lb. the corresponding mean weight for ewes with lambs showed a much greater loss (see Fig. 1).

* In the case of triplets (1 in 1949 and 2 in 1950) the third lamb was removed at birth, and the ewe classed as one with twin lambs.

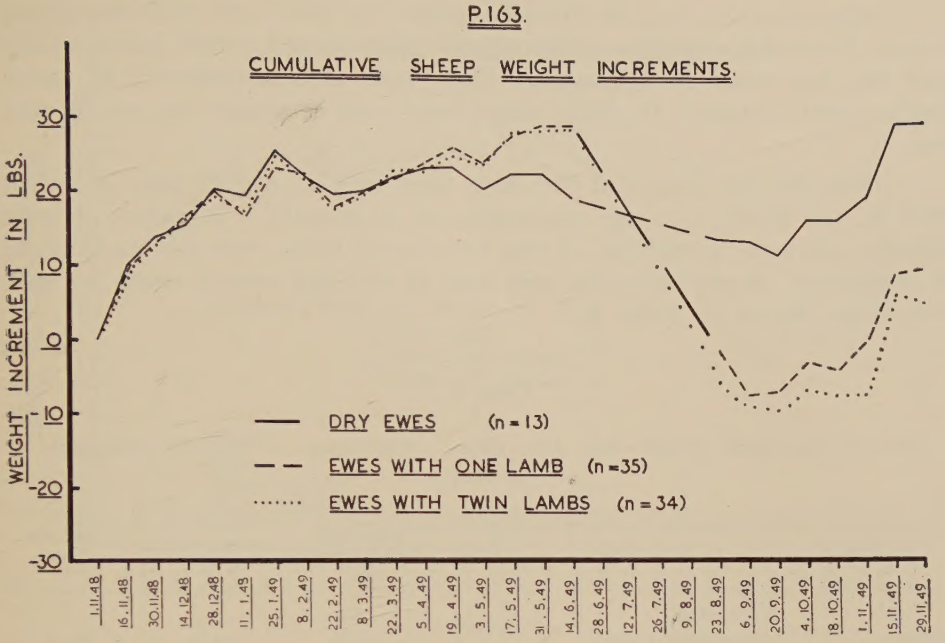

Fig. 1.

Diagram Showing the General Trend of Cumulative Weight Increments (Mean Values for All Pastures) in Dry Ewes, Ewes with One Lamb, and Ewes with Twin Lambs during 1949.

However, within individual flocks (i.e., on each of four pastures) that difference was consistent at a value of approximately 30 lb., and this loss could be attributed to the products of conception, less any subsequent recovery of the ewe (see Table 2).

Table 2.

MEAN LOSS OF WEIGHT FOR DRY EWES AND FOR EWES WITH LAMB ON EACH OF FOUR PASTURES.

Pasture.	Type of Ewe.	No.	Mean Weight. (lb.).		Weight Increment. (lb.).	Ewes with Lamb, cf. Dry Ewes. (lb.).
			14–6–49.	23–8–49.		
Lucerne ..	Dry ewes	1	130·0	137·0	+7·0	..
	Ewes with 1 lamb ..	9	134·3	117·2	−17·1	−24·1
	Ewes with twins ..	11	141·7	117·8	−23·9	−30·9
Grass	Dry ewes	6	124·4	118·3	−6·1	..
	Ewes with 1 lamb ..	8	119·7	81·4	−38·3	−32·2
	Ewes with twins ..	7	128·0	92·3	−35·7	−29·6
Grass + Lucerne	Dry ewes	3	134·8	135·5	+0·7	..
	Ewes with 1 lamb ..	9	133·3	104·0	−29·3	−30·0
	Ewes with twins ..	8	127·2	95·4	−31·8	−32·5
Grass + Phaseolus	Dry ewes	3	121·7	117·7	−4·0	..
	Ewes with 1 lamb ..	9	134·8	97·8	−37·0	−33·0
	Ewes with twins ..	8	132·1	95·3	−36·8	−32·8
					Mean ..	30·7 ± 1·04

After shearing (i.e., as from September 6, 1949) and with the return to more favourable conditions in spring, all sheep gained weight fairly rapidly until the last week in December. They were then transferred to native pastures until January 18, 1950, when they were re-graded for use in that year.

Over the full period of 370 days there was an overall gain in weight (10·5 lb. per head), but any comparison of treatments is a matter of some difficulty, since the proportion of dry ewes, or of twins, was not the same on all treatments. Mean values for each type of ewe and overall means for each pasture are shown in Table 3.

Table 3.

MEAN LIVEWEIGHT GAINS FOR ALL EWES (EXCLUSIVE OF FLEECE WEIGHTS) IN 1949.

Pasture.	Class of Ewe.	No.	Liveweight Gain per Head. (lb.)	Loaded Mean. (lb.)	Arithmetic Mean (lb.)
Lucerne	Dry ewes	1	35·4	..	..
	Ewes with 1 lamb ..	9	23·5	24·8	27·9
	Ewes with twins ..	11	24·9	..	..
Grass	Dry ewes	6	26·6	..	..
	Ewes with 1 lamb ..	8	−4·9	2·1	3·5
	Ewes with twins ..	7	−11·2	..	..
Grass+Lucerne..	Dry ewes	3	39·4	..	..
	Ewes with 1 lamb ..	9	9·8	9·3	15·8
	Ewes with twins ..	8	−2·3	..	..
Grass+Phaseolus	Dry ewes	3	24·2	..	..
	Ewes with 1 lamb ..	9	6·4	6·1	9·9
	Ewes with twins ..	8	−1·0	..	..

These data show that animals held on pure lucerne pastures gained most weight, whereas those on *P. scrobiculatum* alone gained very little. Those on mixed pastures made intermediate gains, with some advantage in favour of the grass + lucerne mixture. In the case of dry ewes these differences were quite small, and it must be assumed that the quality of feed on all four pastures was adequate for this class of sheep. On the other hand, ewes with lamb, and particularly those with twins, showed appreciable differences indicating a sub-optimal level of nutrition on all but the lucerne pastures (see Fig. 2).

(ii) *Data for 1950.*—In 1950 the sheep were in somewhat better condition when the season commenced (mean weight 121·5 lb.), and there was not the same initial rise in the mean weight for all groups. There were

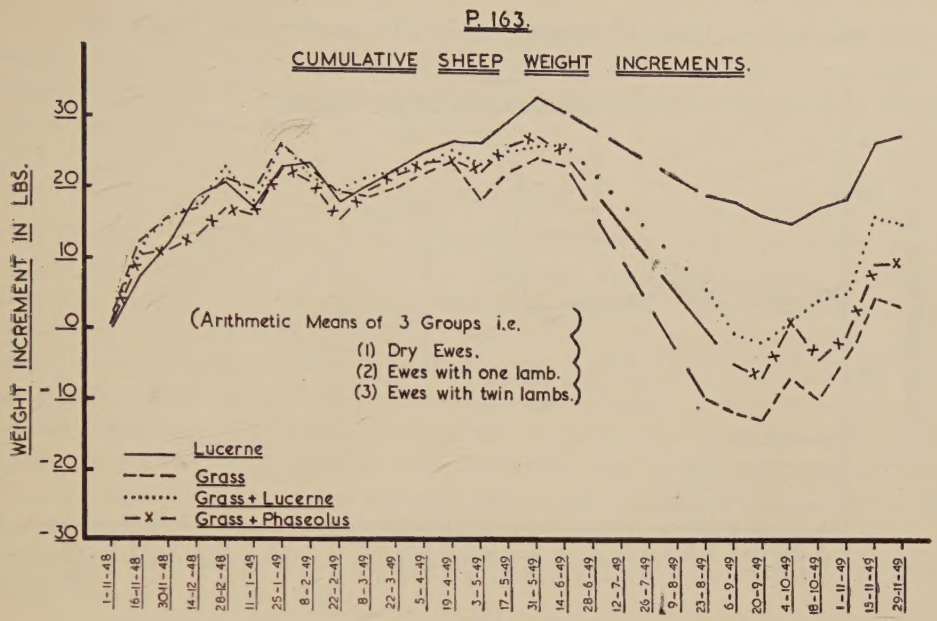

Fig. 2.

Diagram Showing Mean Values for Progressive Liveweight Data on Each of Four Pastures. Curves Based on Data for 1949.

relatively few dry ewes; therefore it was not possible to make the same comparisons at lambing. However, the overall loss at lambing (10 weeks) was much less than in 1949, and there was not the same recovery during lactation.

Over the full period of 372 days the mean weight for all animals showed a loss of approximately 1·1 lb. per head, but here again those that were confined to the lucerne pastures gained about 16 lb., while those on grass alone, or grass + *Phaseolus*, lost approximately 10 lb. (see Table 4).

Table 4.

MEAN LIVEWEIGHT GAINS FOR ALL EWES IN 1950.

Pasture.	Class of Ewe.	No.	Liveweight Gain per Head. (lb.)	Loaded Mean. (lb.)	Arithmetic Mean. (lb.)
Lucerne	Ewes with 1 lamb ..	7	22·1	..	..
	Ewes with twins ..	9	12·2	16·5	17·2
Grass	Ewes with 1 lamb ..	9	−7·1	..	..
	Ewes with twins ..	6	−12·7	−9·3	−9·9
Grass + Lucerne ..	Ewes with 1 lamb ..	9	−0·7	..	..
	Ewes with twins ..	6	1·9	0·3	0·6
Grass + Phaseolus	Ewes with 1 lamb ..	11	−9·8	..	..
	Ewes with twins ..	5	−13·9	−11·1	−11·9

The general trend of liveweights in 1950 is shown in Fig. 3.

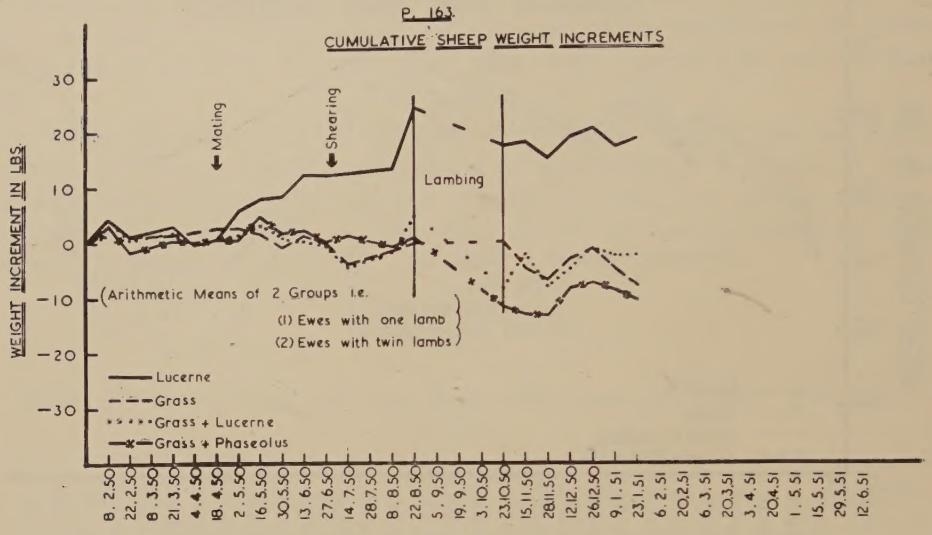

Fig. 3.

Diagram Showing Mean Values for Progressive Liveweight Data in Ewes during 1950.

In both years there was little, if any, growth of the annual legume (*Phaseolus lathyroides*) during lambing and/or lactation, so ewes on this pasture were directly comparable with those on a pure stand of grass.

(*b*) Wool Yields.

The mean yield of wool from ewes on each of these pastures is shown in Table 5. All wools were of a satisfactory type and quality.

Table 5.

MEAN YIELD OF WOOL (LB./HEAD) FROM THREE CLASSES OF EWE ON EACH OF FOUR PASTURES.

Pasture.	Dry Ewes.		Ewes with 1 Lamb.		Ewes with Twin Lambs.		Loaded Mean.		Arithmetic Mean.	
	1949.	1950.	1949.	1950.	1949.	1950.	1949.	1950.	1949.	1950.
Lucerne	9·06	8·85	7·50	7·23	8·44	6·95	8·26	7·10	8·33	7·68
Grass	6·87	5·90	7·13	6·22	7·44	6·55	7·02	6·30	7·15	6·22
Grass+Lucerne ..	7·75	6·30	7·25	6·79	6·81	6·64	7·35	6·68	7·27	6·54
Grass+Phaseolus ..	8·44	6·53	7·56	5·90	7·75	6·18	7·93	6·12	7·92	6·20
Loaded Mean ..	7·81	6·53	7·34	6·46	7·73	6·63	7·63	6·55	..	..
Arithmetic Mean ..	8·03	6·89	7·36	6·53	7·61	6·58	..	..	7·67	6·66

(*Note.*—These sheep were purchased " off shears " in October, 1948, and were shorn, to suit the convenience of the experiment, in August, 1949, and in June, 1950. The above figures for wool yields, for both years, represent 10 months' growth only.)

The data suggest that there was a general tendency towards higher yields from the lucerne pasture and from dry ewes, but there was also a considerable variation in the yields from individual animals within a group, and these differences were not significant.

(*c*) Lamb Data.

Lamb weight data have been derived from weekly records of the weight of animals which were born at different times and matured on feed of changing quality (i.e., at different stages of growth) under varying seasonal conditions. In 1949, for example, lambs born during the second week of June were matured on feed grown during the previous season; those born during the third week of August were partly matured on more succulent new season's growth. This variation, however, was common to all treatments, and mean values for each pasture were calculated by taking the date of birth as zero time, and thereafter average values for the weight of lambs at the age of 1, 2, 3, 4 weeks and so on. Because each lamb was slaughtered at a paddock weight of 63 lb., mean values for any one pasture were not computed after slaughtering was begun.

(i) *Birth weights and percentage lambing.*—Mean birth weights and the percentage of lambs (at marking) are shown in Table 6.

Table 6.

PERCENTAGE LAMBING AND MEAN BIRTH WEIGHT FOR ALL LAMBS BORN IN 1949 AND 1950.

Pasture.	Year.	Lambs at Marking. (%)	Mean Birth Weight.	
			Singles. (lb.)	Twins. (lb.)
Lucerne	1949	147	11·5	9·2
	1950	148	9·9	9·6
Grass	1949	91	9·5	6·5
	1950	134	10·6	8·1
Grass+Lucerne ..	1949	109	10·4	6·9
	1950	119	10·1	9·6
Grass+Phaseolus ..	1949	105	9·3	6·6
	1950	119	9·9	8·5
Mean		121	10·1	8·1

In both years the number of lambs born on lucerne pastures exceeded that for either of the three grass pastures—mean values of 147·5 (from lucerne) and 113 (mean for all grass pastures)—but the difference was not significant. Also the birthweight of twins was consistently less than that of singles, but there were no significant differences between treatments.

(ii) *Growth rates.*—The growth rate of lambs on each of these four pastures was a matter of obvious importance, and in order to make appropriate comparisons the mean weight for all single lambs and for twins was separately plotted against time (i.e., age, in weeks, after birth). In every case the resultant curve was practically a straight line, indicating a close correlation between age and weight (see Fig. 4). Such a remarkable regularity of growth was not anticipated, and no completely satisfactory explanation is available. However, it is reasonable to assume that these lines would lie along a tangent at the point of inflexion in normal sigmoid growth curves, and that differential growth-rates in lambs born at different times would mask any minor inflexions.

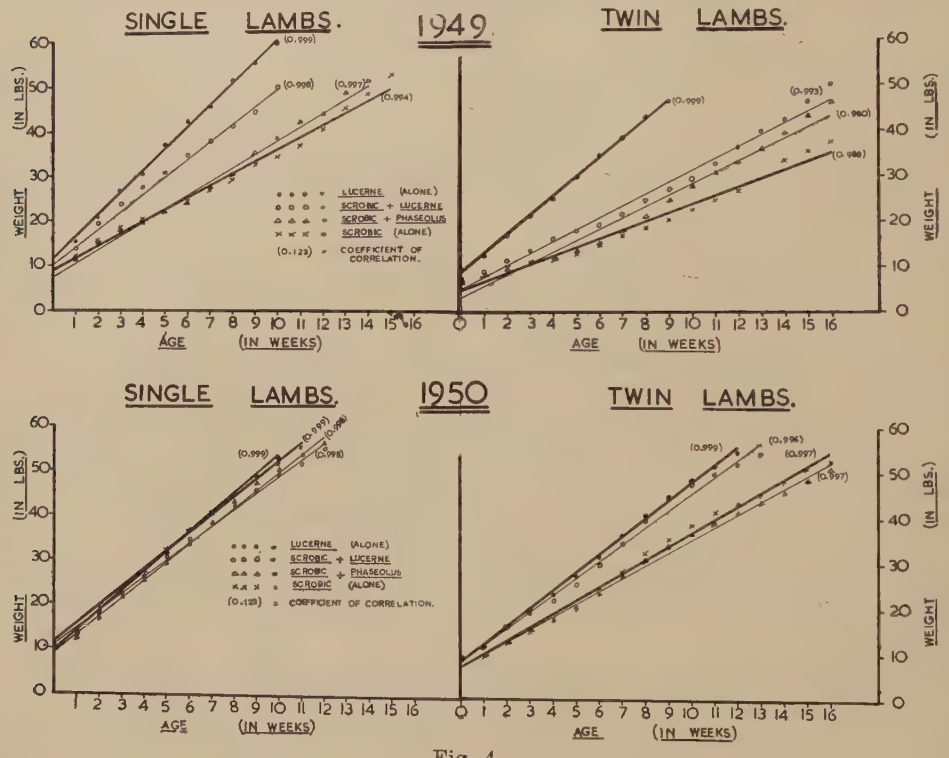

Fig. 4.

Diagram Showing Mean Weight of All Lambs, on Each of Four Pastures, at Weekly Intervals as from the Date of Birth.

The data show that in 1949 (the more rigorous season) there were appreciable differences in the growth rate of lambs matured on different pastures. On the lucerne treatments all lambs, both singles and twins, gained rapidly (up to 5 lb. per week), and they were matured in 10–12 weeks. On "grass alone" and "grass + *Phaseolus*", single lambs took 14 weeks to mature, and the growth rate of twins was still further depressed.

In 1950 the growth rate of single lambs was much the same on all four pastures, and only twin lambs on the "grass alone" and "grass + *Phaseolus*" pastures matured more slowly.

(iii) *Carcass appraisal.*—As these lambs matured (i.e., attained a paddock weight of 63 lb.) they were crated for 12 hours (overnight) to simulate conditions of normal transport to an abattoir, and then slaughtered. The carcasses were then held in cold storage for a further 24 hours, when they were appraised on the basis of a modified block test. Mean paddock weights, liveweight shrinkage (in crates), dressing percentages and carcass shrinkage (in cold store) are shown in Table 7.

Table 7.

SLAUGHTERING DATA FOR 1949 AND 1950.

Pasture.	Year.	Mean Paddock Weight. (lb.)	Mean Pre-Slaughter Weight. (lb.)	Liveweight Shrinkage.		Dressing. (%)	Carcass Shrinkage.	
				(lb.)	(%)		(lb.)	(%)
Lucerne	1949	65·5	61·4	4·1	6·2	55·9	0·8	2·3
	1950	64·2	60·3	3·9	6·1	55·0	0·8	2·4
Grass	1949	61·5	56·9	4·6	7·5	49·7	1·0	3·5
	1950	63·3	58·5	4·8	7·6	50·2	0·9	3·1
Grass+Lucerne ..	1949	62·9	58·4	4·5	7·2	52·9	1·0	3·2
	1950	64·1	58·8	5·3	8·3	53·5	1·0	3·2
Grass+Phaseolus	1949	61·9	57·3	4·6	7·4	50·8	0·8	2·7
	1950	63·4	58·4	5·0	7·9	51·9	1·0	3·4
Mean	1949	63·3	58·8	4·5	7·1	52·9	0·9	2·9
	1950	63·8	59·1	4·7	7·4	52·7	0·9	2·9

These data show that there was a remarkable overall similarity in the slaughter data for lambs in 1949 and 1950. There was also a trend towards better quality from the lucerne pastures (i.e., in terms of dressing percentage, liveweight shrinkage, and carcass shrinkage), but these differences were not significant.

The carcasses were appraised on the basis of seven criteria, as follows:—

Feature.	Score.
(By inspection)	
1. Balance of conformation .. .. .. (fullness of quarters) (flatness of withers) (parallel sides)	0–10
2. Fat cover .. .. (colour 5, distribution 5)	0–10
3. Legs .. .. (well filled and fine boned)	0–10
4. Ribs .. .. (light and well sprung)	0–10

(By measurement)	
5. Leg length (short)	0–10
6. Eye muscles—	
(*a*) Size (large)	0–15
(*b*) Shape (index)	0–15
7. Backfat thickness (correct proportions)	0–20
Total	100

The score assigned to each feature was based on a series of observations recorded for several hundred lamb carcasses in earlier experiments (Briton 1952), and an overall or "total score" was recorded for each carcass.

In each of these seven features a definite relationship was observed between the score awarded and the age of the animal at slaughtering. Lambs which had matured more rapidly gave better quality carcasses.

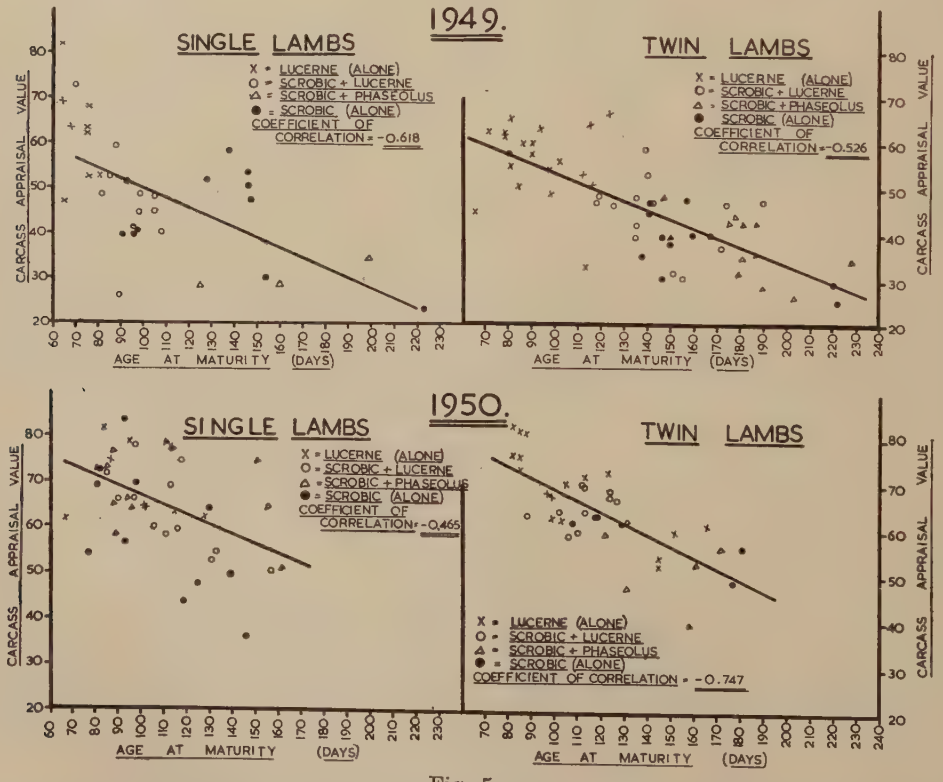

Fig. 5.

Separate Diagrams Showing the Relationship Between Age at Maturity and Appraisal Values for Twin Lambs and for Single Lambs in 1949 and 1950.

Features 1, 3, 4, and 5 would be affected more by genetic differences than by the quality of feed; the others would be more directly related to differences in feed quality. However, earlier work (Briton 1952) had indicated a general relationship between desirable conformation and rate of maturity in lambs of nine different breed combinations, all maintained throughout at an optimum level of nutrition. It would appear, therefore, that within any one breed combination each feature relating to carcass quality follows the same trend in relation to maturity rate, irrespective of whether it is basically a function of breed or not.

The general trend of this relationship between maturity rate and carcass quality is shown in Figs. 5 and 6. The correlations are of a relatively low order (0·465 to 0·747), but this is to be expected when two factors (genetics and nutrition) are both exerting their influence on carcass quality, with varying emphasis on individual features.

The observed relationship between carcass quality and maturity rate appears to hold good irrespective of the type of pasture, and since the scores for individual features all showed the same trend, overall appraisal values (total scores) were plotted against the age at maturity of both single and twin lambs (see Fig. 5).

A similar diagram based on the data for all lambs born on the experiment is shown in Fig. 6.

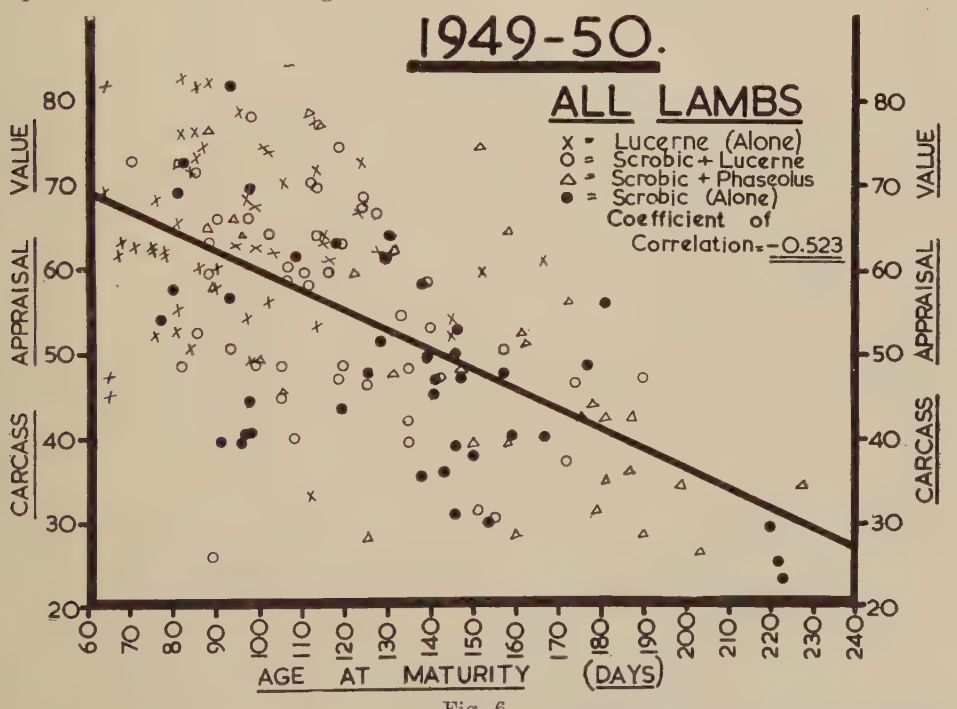

Fig. 6.

Diagram Showing the Relationship Between Age at Maturity and Carcass Appraisal Values for All Lambs Produced in 1949 and 1950.

(*d*) Sheep Numbers and the Intensity of Grazing.

Up to this point all the evidence from this experiment has favoured lucerne pastures as being most suitable for raising fat lambs in south-eastern Queensland. Few significant differences had been recorded, but there has been a general trend in favour of lucerne which was consistent, and which could be summarized as follows:—

(1) Highest weight-gains in ewes were recorded on lucerne pastures.

(2) These sheep gave the highest yields of wool.

(3) There was some increase in the percentage of lambs at marking.

(4) Differences in the growth rate of lambs—when apparent—were all in favour of lucerne pastures.

(5) There was some improvement in the dressed weight (%) with a smaller loss from carcass shrinkage, etc.

(6) There was a higher proportion of first quality carcasses.

In all cases these differences were most pronounced in twin lambs or in the mothers of twins (i.e., under the greatest demand for high level nutrition).

On the other hand, there were also appreciable differences in the carrying capacity of these four pastures, and in this respect the lucerne treatments were at some disadvantage. The experiment was designed deliberately to measure qualitative features of the pastures, and to this end the numbers of sheep were reduced initially to 3·2 ewes per acre and subsequently to as few as 2·2 ewes per acre. Other experiments, both preceding and subsequent to this trial, but using the same plants in various combination, have carried 4·0 dry sheep and/or 3·0 lambing ewes in very good condition, and in some cases under very adverse conditions.

At this intensity of grazing there was at all times an abundance of feed on each of the three grass pastures (grass alone, grass + lucerne, and grass + *Phaseolus*), but the lucerne pastures proved inadequate, particularly in 1949, when additional areas were required to maintain a continuous supply of feed. During that period (i.e., June 15, 1949 to September 20, 1949) the number of sheep/days grazing on all pastures were as shown in Table 8.

In effect these data are not entirely representative, since animals transferred to other paddocks would have an abundance of feed, probably more than sufficient to counteract the effects of any previous shortage when they were held on the experiment. It is also of interest that in this case (i.e., where quantitative factors were involved) there was some definite advantage in favour of the row-cultivated plots.

In 1949 the three grass pastures, comprising a total area of 26·6 acres, carried 81 ewes from November 7, 1948, until lambing (June 14, 1949), and 63 ewes from then until November 29. In addition, one ram and one reserve ewe were added to each subplot during the mating season (i.e., a total of 99 adult sheep for a period of eight weeks commencing January 25, 1949).

Table 8.

GRAZING DATA FOR THE CRITICAL MONTHS IN 1949.

Date.	No. of Ewes.	No. of Days on Experiment.			
		Lucerne.			Common Value for All Grass Pastures (Sub-plot.)
		Sward.	42″ Rows.	63″ Rows.	
15/6—25/6	9	14	10	7	14
26/6—12/7	9	14	14	13	14
13/7—26/7	7	10	14	15	14
27/7— 9/8	7	Nil	Nil	Nil	14
10/8—23/8	7	10	10	10	14
24/8— 6/9	7	7	10	14	14
7/9—20/9	7	7	10	14	14
Total Sheep Days		483	524	551	742
Relative Grazing Intensity		65	71	74	100
		Mean 70			

From June 14, 1949, the number of lambs rose steadily to a total of 64, of which the majority were maintained on these three pastures from August 21, 1949, to November 29, 1949. Assuming a lamb to be the equivalent of one extra sheep for half its life, it has been estimated that the three grass pastures provided 32,986 sheep/days grazing (i.e., an equivalent of 3·2 sheep per acre). On the same basis the lucerne pastures carried approximately 2·9 sheep per acre.

In 1950 conditions were more favourable and good feed was available in greater quantity. However, in view of the number of multiple lambings (twins and triplets) that occurred in 1949, it was decided to reduce the intensity of grazing to 2·6 ewes per acre until the last week in August (lambing) and thereafter to 2·2 ewes per acre.

The three grass pastures therefore carried a total of 63 ewes until the last week in August, and thereafter 54 ewes until June 1951. As before, during the mating season (i.e., eight weeks commencing April 11, 1950), one ram and one reserve ewe were added to each subplot, and during the period August 31, 1950, to January 24, 1951, the number of lambs rose steadily to a total of 72. It has been estimated that over a period of 12 months these three pastures provided 26,060 sheep/days grazing (i.e., the equivalent of 2·7 sheep per acre). The lucerne pastures carried approximately 2·4 sheep per acre.

Over the full 2-year period, each of the three grass pastures carried 2·6 lambing ewes per acre, and the lucerne pastures carried 2·0 lambing ewes per acre. Under these conditions the lucerne pastures were grazed to capacity, but on all grass pastures the supply of available feed was at all times in excess of the demand.

IV. DISCUSSION.

In Queensland the fat lamb industry is at present of relatively minor importance, and lamb meat constitutes only 1% of meat passing through the Brisbane Abattoir. Current statistics for Brisbane and for the whole of New South Wales are shown in Table 9. The numbers of sheep in Queensland

Table 9.

Annual Consumption of Meat (in lb.) per Head of Population.

——	Beef.	Veal.	Mutton.	Lamb.	Total.
Brisbane..	165	190	21	4	380
New South Wales ..	124	1	35	28	188

suited to fat-lamb production are so small that they have evidently been considered not worth recording in the statistical data for the State (see Table 10). At the present time nearly all locally produced fat lambs are

Table 10.

Statistical Table of Intended Matings for 1951 (1,000,000 Ewes).

Breed.	N.S.W.	Vic.	S.A.	W.A.	Tas.	Qld.
Merinos, Corriedales, and Polworths (mainly wool-growing sheep) ..	16·0	4·2	3·5	4·2	0·5	7·3
Others (including fat lamb sheep) ..	4·6	4·4	1·0	0·6	0·6	..

reared on the Darling Downs, where cereal crops (wheat and oats) are used for winter feed. In that district there are approximately 2·7 million sheep.

The main factors limiting the production of fat lambs in Queensland are (1) the uncertainty of subtropical rainfall and the poor quality of native pastures in winter and spring, and (2) the normal breeding season of British breed ewes, which necessitates mating in late summer or autumn, with the result that lambing occurs when native pastures are of very low feed value.

This experiment is one of a series which show clearly that, given satisfactory sown pastures, there is no fundamental reason why fat lambs should not make an important contribution to food production in Queensland, and thereby to Australian food production. If the production of lamb meat is to increase in Queensland, it is highly desirable that top quality "sucker" lamb carcasses should be the objective. High quality lamb meat can be expected to find ready acceptance both for local consumption and for export. Lesser quality carcasses and "carry-over" lambs should be avoided. The close correlation obtained between the age of the lambs at slaughter and carcass quality demonstrates the importance of rapidly maturing the lamb crop.

The grass *Paspalum scrobiculatum,* when utilized in association with lucerne grown under row cultivation, can provide satisfactory pasturage in south-eastern Queensland for quality lamb production. The important characteristics of these pastures are:—

(1) The grass *Paspalum scrobiculatum* provides a bulk supply of winter feed for the dry ewe flock in the form of standing foggage. This is both palatable and readily digestible, and it is, of itself, almost sufficient to maintain dry ewes in good condition.

(2) Under row cultivation the lucerne pastures will provide virtually a continuous supply of protein and of green feed, at least sufficient to ensure maximum consumption of the bulk of grass.

Under normal seasonal conditions a late mating (March-April) is desirable. Mating at this period is conducive to high lambing percentages, whilst the grass (*P. scrobiculatum*) will invariably make new growth in spring when mean temperatures rise above a threshold value (Paltridge 1954). High quality feed is thus available when it is most needed for the lambing and lactating ewes. Lambing in spring will allow also for maturity of the lamb crop in late December or January. After disposal of the lambs for slaughter the ewes can be removed to allow full growth and production of a large bulk of feed in readiness for the ensuing winter.

At that time (late summer) the incidence of effective summer rains will normally provide an abundance of feed of reasonably good quality on native pasture and/or on cultivated land; and, in any case, if the ewes were to lose weight during this period, the disadvantage would be more apparent than real, since they would be returned to the sown pastures almost two weeks before mating, when a rising level of nutrition would favour a high rate of conception.

This type of management would therefore approach ideal conditions, both for the animals and for the sown pastures.

V. ACKNOWLEDGEMENT.

The authors wish to express their appreciation of facilities provided by C.S.I.R.O. and by the Queensland Department of Public Instruction, and they are especially indebted to Mr. J. G. Downing (C.S.I.R.O. Technical Officer), who was responsible for all field observation and for the general management of this experiment. They wish also to acknowledge their indebtedness to Mr. G. Carson-Cooling for advice and help in preparation of this manuscript.

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(Received for publication April 21, 1954.)

LEPTOSPIRA POMONA AS A CAUSE OF ABORTION AND NEONATAL MORTALITY IN SWINE.

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SUMMARY.

The effect of Leptospira pomona infection of sows during pregnancy was studied.

Four sows infected intramuscularly with a culture of L. pomona in the second half of pregnancy produced 37 piglets, of which 34 were born dead or died within a few minutes of birth. Four uninfected sows kept under similar conditions produced 35 piglets, of which six were born dead or died within a few minutes of birth.

The average gestation period in the four uninfected sows was 115 days, whereas in the four infected sows the average period was 95 days. The duration of abortion in the infected sows appeared to be longer than farrowing in the uninfected sows.

There was no clinical evidence of ill health in three of the four sows, but the other showed a temperature reaction and anorexia for a few days.

The infected sows commenced excreting Leptospira in the urine 17, 19, 9 and 10 days after infection and excreted for a period of 5, 7, 83 and 24 days respectively.

Approximately 40% of the dead piglets of the infected sows showed focal necrosis of the liver and excess serous fluid in the body cavities. The remainder were either macroscopically normal or were partly decomposed.

Leptospira were isolated from 12 of 35 piglets from the infected sows.

The diagnosis of porcine leptospiral abortion is discussed. It is recommended that dead piglets be examined by microscopic examination of peritoneal fluid and guinea pig inoculation of tissues.

INTRODUCTION.

Observations on two naturally infected herds of swine and on one experimentally infected sow indicated that *Leptospira pomona* infection may result in the birth of weak or dead piglets (Ryley and Simmons 1954). To our knowledge no further experimental work on swine leptospirosis has been published subsequent to the submission of that paper, although Reinhard (1953) in a review of the subject quoted a personal communication stating that Leptospira had been recovered from aborted porcine foetuses.

The present paper records observations on a further four sows experimentally infected with *L. pomona*, and on four other comparable uninfected sows kept under the same conditions.

METHODS.

Experimental Sows.

Eight maiden sows and a boar of the Large White breed were selected from a brucellosis-tested piggery, after blood samples from these animals were found negative to the agglutination tests for brucellosis and *L. pomona*.

Housing.

The sows were run together until a few days before infection, then separated, each being placed in a concrete pen, 8·5 ft. x 18·5 ft. Nine pens in a row were used, the group selected for infection with Leptospira being separated from the uninfected sows by an empty pen. The uninfected sows were always attended first.

Feeding.

The sows and the boar were fed from about two weeks before mating commenced on a mixture containing:—

	Per cent. (by weight).
Crushed sorghum	18
Crushed wheat	30
Crushed maize	25
Meatmeal (55% crude protein)	12
Dried buttermilk powder (35% crude protein)	3
Livermeal (65% crude protein)	3
Lucerne chaff	5
Bran	2
Ground limestone	1
Salt	1

A fish-liver oil emulsion was added to the mixture to provide approximately 5,000 I.U. of vitamin A per lb.

The ration, which provided approximately 19% crude protein, was mixed weekly. Approximately 5 lb. was fed dry per day to each sow at the beginning of the experiment, but this was gradually increased to 6 lb. at farrowing. Freshly cut lucerne was fed at the rate of 2–3 lb. daily.

Clinical Observations.

The sows were examined daily and rectal temperatures recorded twice daily during the course of the experiment.

Urine Specimens.

Daily urine samples were collected from the infected animals and examined as described previously (Ryley and Simmons 1954). Samples were collected at least once and usually twice weekly from the uninfected sows.

Strain of Leptospira.

The *L. pomona* strain described in our other paper (Ryley and Simmons 1954) was used. Four sows (Nos. 3, 4, 5 and 6) were inoculated intramuscularly with 1·0 ml. of culture from the twenty-fifth guinea pig passage, while the remaining four (Nos. 7, 11, 12 and 40) served as uninfected controls. Both groups were comparable in body weights and dates of service.

The weights of the control sows three weeks before infection date varied between 257 lb. and 297 lb. (average 282 lb.) and of the infected group between 263 lb. and 306 lb. (average 285 lb.).

Agglutination Tests.

Blood samples were collected at intervals varying from 10 days to one month. The sera were kept at –25°C. until the end of the experiment and then examined by the agglutination test (Ryley and Simmons 1954).

Examination of the Piglets.

Farrowing was observed whenever possible and any dead piglets autopsied within 12 hours. A loopful of pleural fluid, peritoneal fluid, stomach content and urine was examined by dark ground illumination. Portion of the lung, liver, stomach content and kidney was ground with sterile sand and saline and 1 ml. of the supernatant inoculated intraperitoneally into guinea pigs of approximately 250 g. weight. Liver and kidney was sown on sheep's blood agar plates to check for *Brucella* spp. Rectal temperatures of the guinea pigs were recorded twice daily for one week; peritoneal fluid of those showing a temperature over 104°F. was obtained by the method of Van Thiel (1948) and examined for Leptospira by dark ground illumination. All guinea pigs were slaughtered after three weeks and their sera submitted to agglutination tests for *L. pomona* and brucellosis.

RESULTS.

Clinical Observations.

The uninfected sows remained healthy throughout the experiment, except sow 11, which had Group C streptococcal mastitis in the posterior unsuckled teats nine days after farrowing. This sow was treated by intramuscular inoculation of 500,000 units of procaine penicillin daily for three days and recovered.

Temperature charts of the four infected sows (Nos. 3, 4, 5 and 6) are shown in Figs. 1-4. Sow 3 showed no abnormality except a slight rise (103·8°F.) on the thirteenth day after inoculation (Fig. 1). Sow 4 also remained normal and showed a rise (104·2°F.) on the day after farrowing (Fig. 2).

Sow 5 had inappetance on the fifth and sixth days after infection and temperatures of 103·7°F. four days after inoculation and 104·0°F. on the afternoon of the day of farrowing.

Sow 6 had two periods of ill health. She showed dullness and anorexia between the fifth and seventh days after infection with an increased temperature between the third and seventh days, reaching a peak of 105·5°F. on the afternoon of the fourth day. Anorexia and a slight ocular discharge occurred on the sixth to seventeenth day after farrowing, with a temperature rise between the sixth and twelfth days. The highest temperature of 105·6°F. was recorded on the afternoon of the seventh day. Appetite gradually returned and was normal on the twentieth day after farrowing.

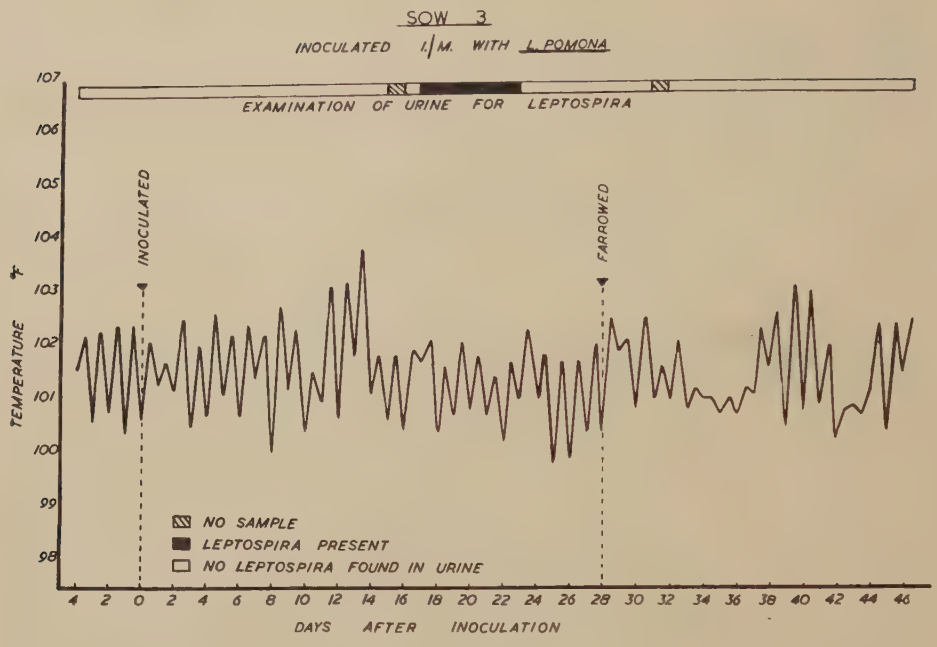

Fig. 1.

Sow 3 Inoculated Intramuscularly with a Culture of *L. pomona*. Rectal temperatures twice daily and results of dark ground examinations of urine for Leptospira.

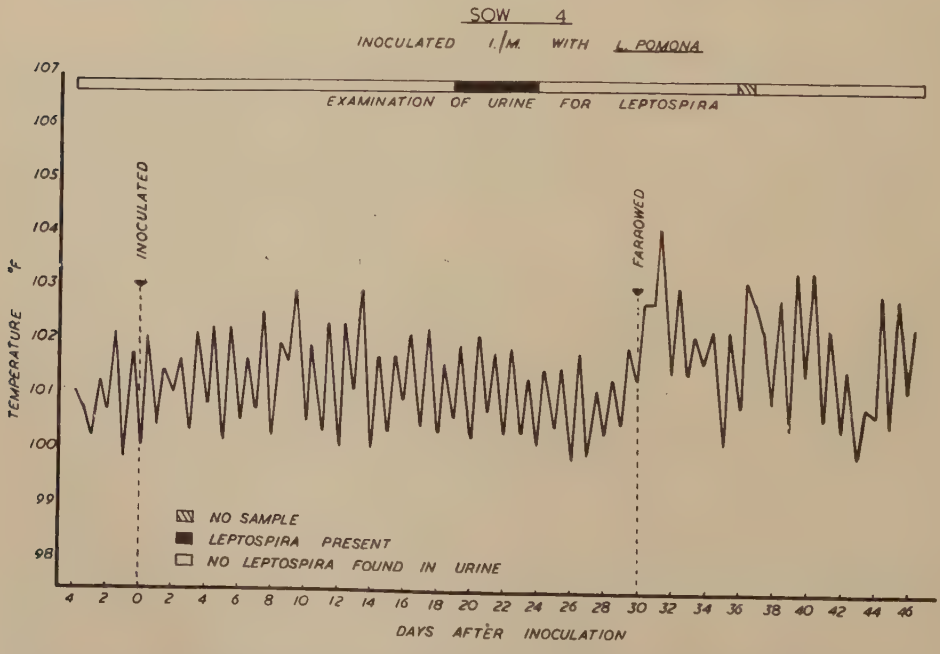

Fig. 2.

Sow 4 Inoculated Intramuscularly with a Culture of *L. pomona*. Rectal temperatures twice daily and results of dark ground examinations of urine for Leptospira.

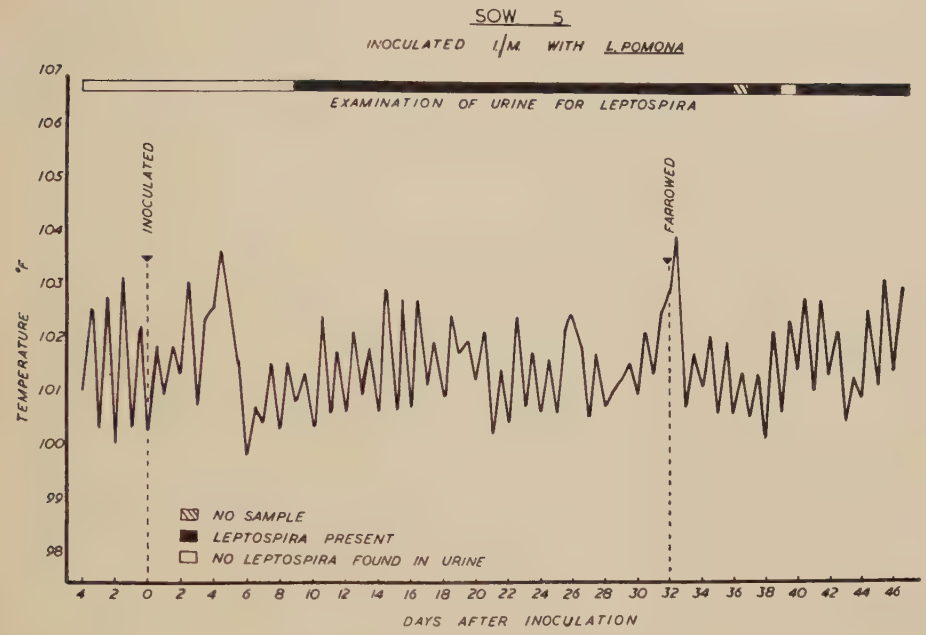

Fig. 3.

Sow 5 Inoculated Intramuscularly with a Culture of *L. pomona*. Rectal temperatures twice daily and results of dark ground examinations of urine for Leptospira.

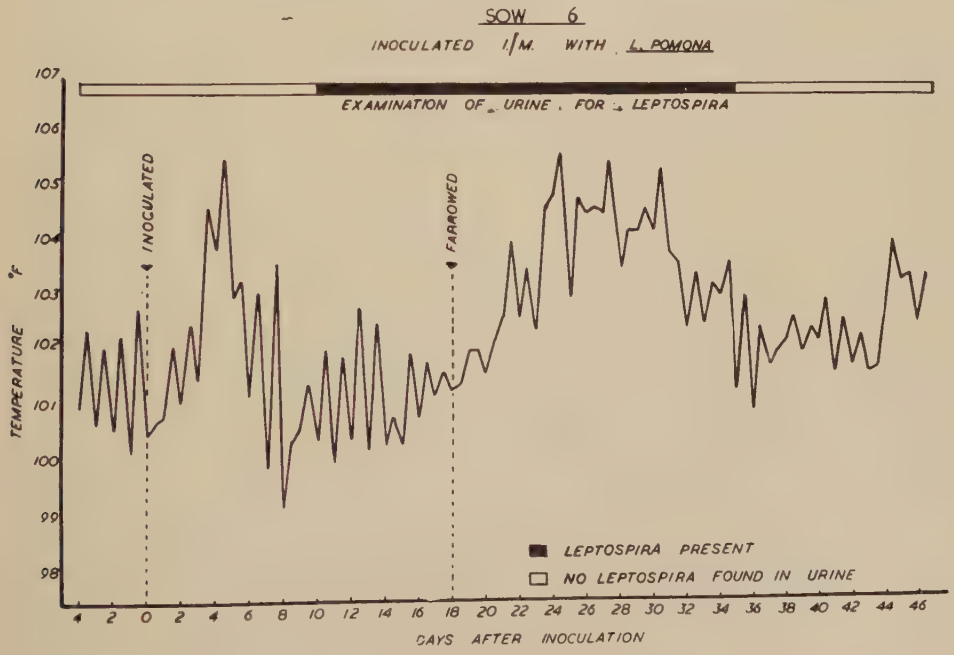

Fig. 4.

Sow 6 Inoculated Intramuscularly with a Culture of *L. pomona*. Rectal temperatures twice daily and results of dark ground examinations of urine for Leptospira.

Urine Examination.

Between 14 and 20 urine samples were collected from each uninfected sow during the experimental period, and all were negative for Leptospira.

Results of urine examinations of the infected sows are given in Figs. 1-4. The commencement, cessation and duration of leptospiruria were as follows:—

Sow No.	Leptospiruria. (days after inoculation).		Duration. (days.)
	Commenced.	Ceased.	
3	17	24	7
4	19	24	5
5	9	92	83
6	10	34	24

Sows 3 and 4 ceased excreting Leptospira five and seven days respectively before aborting. Sows 5 and 6 were excreting them at the time of parturition.

Serology.

The results of the agglutination tests are shown in Table 1.

Table 1.

Results of Agglutination Tests on Sera from Uninfected and Infected Sows.

Sow No.	Dec. 4.	Dec. 10.	Dec. 22.	Jan. 15.	Feb. 15.	March 8.
7	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
40	...	...	...	0	0	0
3	0	0	300*	3,000	1,000	300
4	0	0	1,000	300	300	100
5	0	0	1,000	3,000	3,000	3,000
6	0	0	1,000	30,000	10,000	10,000

Key :— * Reciprocals of titres. Read at approximately 50% agglutination.
0 = No agglutination.
... = No sample.

Note :—The infected sows were inoculated on December 11.

Sera from the four uninfected sows showed no agglutination whereas those from the four infected sows had a maximum titre of between 1:300 and 1:30,000. Eleven days after inoculation all infected sows showed a titre of 1:300 or greater. The highest titre (1:30,000) occurred in the sera from sow 6, which showed symptoms of anorexia and hyperpyrexia. It will be noted that two of the four infected sows, Nos. 3 and 4, showed titres of 1:300 and 1:1,000 respectively before Leptospira were found in the urine. The other two sows were excreting Leptospira before the first post-infection bleeding.

Details of Farrowing.

The gestation periods and number of piglets born are shown in Table 2.

Table 2.

PARTICULARS OF GESTATION PERIODS AND LITTERS OF UNINFECTED AND INFECTED SOWS.

Sow No.	Date of Service.	Date of Infection.	Date of Parturition.	Gestation Period. (days)	Number of Piglets.		
					Born.	Born dead.	Survived 2 days.
7	Oct. 9	Nil	Feb. 1	115	8	0	8
11*	Oct. 10	Nil	Feb. 3	116	11	3	4
12	Sept. 15	Nil	Jan. 8	115	2	0	2
40	Oct. 25	Nil	Feb. 16	114	14	3	11
3	Oct. 12	Dec. 11	Jan. 10	90	13	13	0
4	Oct. 11	Dec. 11	Jan. 11	92	6	6	0
5	Oct. 14	Dec. 11	Jan. 13	91	10	10	0
6	Sept. 14	Dec. 11	Dec. 30	107	8	5	1

* Litter with congenital defects.

Three of the uninfected sows farrowed within three hours and the fourth (sow 40) farrowed 13 of the 14 piglets during 90 minutes and the last piglet within 10 hours.

In the infected group farrowing occupied 22 hours in sow 4, was less than 16 hours in sow 3 (overnight), between 4 hours and 8 hours in sow 5 and 6-12 hours in sow 6. Sows 3, 4 and 5 aborted, while in sow 6 pregnancy terminated a week before the due date.

The four uninfected sows produced 35 piglets, of which six were dead or died within a few minutes of birth. One of these six was a partially resorbed mummified foetus (Table 3). All the piglets produced by sow 11 showed the congenital defect "kinky tail" (Donald 1949), which will be described in a later paper by Ryley and Melville. Of the eight live piglets in this litter, five had cleft palates and were either destroyed or died within the first three days because of their inability to suckle. One piglet from sow 7 died from overlying on the fourth day.

The four infected sows produced 37 piglets, of which 34 were dead or died within a few minutes of birth (Table 4). Of the three live piglets, one died after five hours, another within 48 hours and the third was weaned at eight weeks. Serological evidence and urine examinations indicated that this piglet was not infected.

Table 3.

BIRTH WEIGHTS, SURVIVAL, PATHOLOGY AND BACTERIOLOGY OF PIGLETS FROM UNINFECTED SOWS.

Sow No.	Piglet No.	Birth Weight. (lb.)	Survival.	Pathology.	Bacteriology.
7	1	2·3	Weaned	...	...
	2	2·4	Weaned	...	...
	3	2·6	Weaned	...	...
	4	2·3	Weaned	...	...
	5	1·9	3 days	Trauma and ruptured liver	—
	6	2·6	Weaned	...	...
	7	2·5	Weaned	...	...
	8	2·8	Weaned	...	...
11	9	1·5	2 days	Stomach empty. Hare lip and cleft palate	—
	10	2·1	Weaned	...	...
	11	2·3	Weaned	...	...
	12	1·9	Weaned	...	...
	13	2·1	3 days	Stomach empty. Hare lip and cleft palate	—
	14	2·3	5 hours	Destroyed. Hare lip and cleft palate	—
	15	1·9	5 hours	Destroyed. Hare lip and cleft palate	—
	16	1·5	5 hours	Destroyed. Hare lip and cleft palate	—
	17	1·8	0	Hare lip and cleft palate	—
	18	0·9	0	Decomposed. Hare lip and cleft palate	—
	19	0·3	0	Mummified. Hare lip and cleft palate	...
12	20	3·2	Weaned	...	...
	21	2·5	Weaned	...	...
40	22	1·8	Weaned	...	...
	23	2·7	Weaned	...	...
	24	1·9	Weaned	...	...
	25	1·9	Weaned	...	...
	26	2·4	Weaned	...	...
	27	1·2	0	Lungs atelectic. N.A.D.	—
	28	1·8	Weaned	...	...
	29	1·5	Weaned	...	...
	30	1·9	0	Lungs inflated. N.A.D.	—
	31	1·7	Weaned	...	...
	32	1·5	Weaned	...	...
	33	2·3	Weaned	...	...
	34	1·9	0	Lungs atelectic. N.A.D.	—
	35	2·3	Weaned	...	...

Key :—N.A.D. = No abnormality detected.
... = No examination.
— = Negative.

Pathology of Piglets.

No significant abnormalities were seen in any piglets from the uninfected sows, except for the congenital defects in the litter of sow 11. Only two of the dead piglets (Nos. 18 and 19 from sow 11) showed evidence of partial decomposition at birth.

Twenty-four of the 36 piglets from the infected sows showed either focal necrosis of the liver with excess clear yellow pleural and peritoneal fluid or blood-stained fluid throughout the subcutis and in the pleural and peritoneal cavities. The necrotic foci varied in number, were irregular in shape and 1-4 mm. in diameter (Fig. 5). Histologically the livers with macroscopic lesions showed foci of acute necrosis, with distinct margins and almost no cellular reaction. There was no significant abnormality in 10 of the piglets and two were mummified. Thirteen piglets showed evidence of death having occurred some time prior to birth (Table 4).

Some of the foetal membranes from the infected sows showed thickening and oedema of the chorio-allantois and an irregular whitish deposit on the uterine surface of the chorion. Membranes of the decomposed piglets were necrotic and greyish-brown in colour. Some decomposed membranes had red or brown raised circular areas 1-4 mm. in diameter.

Table 4.

Birth Weights, Survival, Pathology and Bacteriology of Piglets from Infected Sows.

Sow No.	Piglet No.	Birth Weight. (lb.)	Survival.	Pathology.	Bacteriology.
3	1	1·0	0	N.A.D.	+
	2	0·7	0	N.A.D.	...
	3	1·3	0	Focal necrosis of liver. Excess serous fluid	+
	4	1·3	0	Liver orange and friable	—
	5	1·0	0	Focal necrosis of liver. Excess serous fluid	+
	6	0·5	0	Focal necrosis of liver	+
	7	0·9	0	N.A.D.	—
	8	1·4	0	N.A.D.	—
	9	1·1	0	N.A.D.	—
	10	0·8	0	Decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	11	0·7	0	Decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	12	0·4	0	Decomposed. N.A.D.	—
	13	0·2	0	Partially resorbed mummified foetus	...

Table 4—*continued.*

Sow No.	Piglet No.	Birth Weight. (lb.)	Survival.	Pathology.	Bacteriology.
4	14	1·2	0	Decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	15	1·5	0	Inflated lungs. N.A.D.	—
	16	1·5	0	Injuries by sow after death	—
	17	1·5	0	Inflated lungs N.A.D.	—
	18	1·6	0	Decomposed. Focal necrosis of liver. Blood-stained fluid in peritoneal and pleural cavities and stomach	—
	19	1·3	0	N.A.D.	—
5	20	0·3	0	Mummified	—
	21	0·7	0	Slightly decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	22	0·7	0	Slightly decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	23	0·8	0	Focal necrosis of liver. Excess serous fluid	+
	24	0·7	0	Focal necrosis of liver	+
	25	0·6	0	Focal necrosis of liver. Excess serous fluid	+
	26	0·8	0	Focal necrosis of liver. Excess serous fluid	+
	27	0·6	0	Focal necrosis and reddish depressed areas in liver. Excess serous fluid	+
	28	0·8	0	Excess serous fluid	+
	29	0·8	0	Focal necrosis of liver. Excess serous fluid	+
6	30	1·8	0	Decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	31	1·6	0	Decomposed. Focal necrosis of liver. Blood-stained fluid in pleural and peritoneal cavities	—
	32	1·7	5 hours	Focal necrosis of liver. Excess serous fluid	+
	33	1·5	0	Focal necrosis of liver. Excess serous fluid. Petechiae on epicardium	—
	24	1·4	0	Decomposed. Blood-stained subcutaneous, pleural and peritoneal fluid	—
	35	2·4	0	Decomposed. Focal necrosis of liver. Blood-stained peritoneal and pleural fluid	—
	36	1·8	1 day	Focal necrosis of liver	—
	37	2·1	Weaned	...	...

Key :—N.A.D. = No abnormality detected.
... = No examination.
— = Negative.

Bacteriology of Piglets.

No Brucella were isolated from any of the dead piglets by culture and guinea pig inoculation.

No Leptospira were isolated from the dead piglets of the uninfected sows, but 12 of the 35 piglets examined from the infected sows were found to be infected. All these 12 piglets were shown to be infected by guinea pig inoculation, but only nine of them were positive on direct examination. Of the nine piglets showing Leptospira on direct examination, all showed

Fig. 5.

Portion of the Liver of Piglet No. 23 (Infected) Showing Focal Necrosis.

Leptospira in the peritoneal fluid, 7 in the pleural fluid, 4 in the urine and one in the stomach contents. Sera from the infected guinea pigs agglutinated a known strain of *L. pomona*. Leptospira were not recovered from any of the piglets of sow 4 (Table 5).

Dark ground examination of the foetal membranes from one sow was positive, from another negative; the membranes from the other two sows were not examined.

Table 5.

RESULTS OF EXAMINATION FOR LEPTOSPIRA OF DEAD PIGLETS FROM UNINFECTED AND INFECTED SOWS.

Sow No.	Number of Piglets Examined.	Number Infected.		
		Microscopic Examination.	Guinea Pig Inoculation.	Total.
7	1	0	0	0
11	0	0	0	0
12	7	0	0	0
40	3	0	0	0
3	12	2	4	4
4	6	0	0	0
5	10	6	7	7
6	7	1	1	1

DISCUSSION.

Four sows infected with *Leptospira pomona* in the second half of pregnancy produced 34 stillborn piglets out of 37 piglets born. Four uninfected sows kept under similar conditions produced six stillborn piglets out of 35 piglets born.

Three of the four infected sows aborted 3-4 weeks before full term, whilst the other farrowed one week before the anticipated date. The four uninfected sows farrowed at term. Protracted parturition in the infected sows is probably not specific for leptospiral abortion, as it also occurs in Brucella infection (Thomsen 1935).

Two infected sows showed no clinical evidence of the disease, one showed a transient inappetance which could have been overlooked in communal feeding, while the fourth was dull, fevered and did not eat for some days. The latter did not show icterus or haemoglobinuria commonly associated with leptospirosis in other species of animals. There was no clinical evidence of meningeal involvement, although this is often present in human cases (Van Thiel 1948).

The piglets from the infected sows were normally developed, but because of the shorter gestation period their weights were lower than those from the uninfected sows. The state of some of the foetuses at birth would indicate that death had occurred *in utero* several days prior to expulsion. As only one piglet from an infected sow survived we have insufficient data on the effect of leptospirosis on the growth of piglets. However, it was observed that this piglet and two others born alive were not active and did not try to suckle immediately after birth.

The presence of focal necrosis of the liver in stillborn piglets shows clearly that they were infected *in utero*. The interval between intra-uterine death and expulsion appeared to determine whether these lesions were present and had some bearing on the chance of isolating the organism. Piglets that died at or just prior to birth often showed this lesion and Leptospira were present, whereas those that had died earlier showed only partial decomposition and we were unable to recover Leptospira from any of them. In contrast with normal foetal membranes, those produced by infected sows were either thickened and oedematous or brown and necrotic. As two of the sows showed no significant temperature rise it is suggested that abortion is not due to pyrexia but to infection of the foetus and its membranes.

The period of leptospiruria varied considerably, ranging from 5 days to 83 days. This is much shorter than that recorded by Schmid and Giovanella (1947) for young pigs. It would be interesting to study the effect of age and pregnancy on the duration of leptospiruria. In two of our infected sows the agglutination titre was positive before the organism appeared in the urine.

Our present knowledge of herd history and clinical symptoms in leptospiral abortion is not sufficient to permit differentiation from other causes of abortion. Presumptive evidence can be obtained by serum agglutination tests and dark ground examination of urine from the breeding sows. The interpretation of serological reactions is difficult, as a positive reaction may occur in recovered animals. We consider that a sow excreting Leptospira in the urine in the pregnancy may produce an unsatisfactory litter, but that absence of Leptospira in a urine sample does not ensure that the litter will be free of the effects of leptospiral infection of the sow.

Examination of the dead piglets or foetuses is the best method of diagnosis. As not all dead piglets in a litter may show the lesions and/or harbour the organism, all those born dead should be examined. However, in some litters Leptospira cannot be detected in any of the piglets. Mummified foetuses, which may also occur in litters from uninfected sows, are unsuitable for examination.

The piglets should be examined for evidence of focal necrosis of the liver, and the peritoneal and pleural fluid should be examined under dark ground illumination. As the epidemiology of *L. pomona* infection may differ from that of other species of Leptospira, it is desirable that the strain be isolated and identified. Guinea pig inoculation is more satisfactory for isolation than culture of material because of the frequent presence of bacterial contaminants.

Our experimental results indicate that economic loss associated with the adult pig is small, but that loss associated with the birth of dead piglets can be considerable.

There is a danger of infection of man, not only from infected urine, but also from the handling of foetuses or membranes.

Although our experiments showed that sows infected in the second half of pregnancy may abort and produce dead piglets, we do not know whether this will also occur if the sows are infected before mating, during early pregnancy or in very late pregnancy.

The four infected sows used in this experiment have now been re-mated to the same boar to study subsequent breeding performance.

ACKNOWLEDGEMENTS.

The assistance of Mr. E. L. Melville (Senior Adviser in Pig Raising) in arranging the purchase of the experimental sows, and the technical assistance of Messrs. L. L. Callow, L. Laws, J. Riley and D. J. Webster (Assistant Veterinary Officers, Queensland Department of Agriculture and Stock) is greatly appreciated.

The photographs were taken by the Photographic Section, Queensland Department of Agriculture and Stock.

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(Received for publication May 24, 1954.)

THE ACCURACY OF ESTIMATION OF A DAIRY COW'S PRODUCTION OF MILK AND BUTTERFAT.

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SUMMARY.

Calculated milk productions for 89 Jersey cows based on yield recordings made at weekly, fortnightly and monthly intervals were compared with actual production.

Butterfat productions for 53 lactations were calculated from yield and test records made at weekly and monthly intervals and compared with actual butterfat yields.

The results indicated that in experiments involving the production of a small number of cows, the shortest recording interval that could be used to ensure a reasonable degree of accuracy would be one week. A longer interval would be suitable where a larger number of cows was involved and the recordings averaged, as the plus errors would then tend to cancel out the minus errors.

INTRODUCTION.

In the course of experimental work involving an estimation of the production response of dairy cows to various treatments, it was found that quite a considerable error appeared to exist when the lactation records were computed from milk weighings and butterfat tests made at monthly intervals. In order to test the accuracy of this and other methods, the records obtained at monthly, fortnightly and weekly intervals were compared with the actual production figures.

METHOD.

The production figures studied were obtained from the Jersey herd at Kairi Regional Experiment Station, on the Atherton Tableland in northern Queensland, during the period June 1950 to October 1953. The records of all cows which had been lactating for 130 days or more were included.

On the Station the actual milk production of the cows is obtained by weighing the milk produced at each milking. The butterfat content of the milk is measured once weekly and estimations of milk production were made by multiplying the number of pounds of milk produced on testing days by 7, also by 14. The monthly figures were obtained by multiplying the test figure in the second week of every month by 30. Estimations based on weekly, fortnightly and monthly tests were then compared with actual production.

In addition, the milk production was estimated on a monthly basis, but corrections were applied to account for the date of calving and the date of cessation of lactation and also for the amount by which the actual testing interval differed from 30 days. This is referred to by us as the adjusted monthly production.

The cows were milked twice daily throughout the period during which the records were obtained.

RESULTS.

Eighty-nine lactations were used in the comparison of weekly, fortnightly, monthly and adjusted monthly milk productions with the actual milk production. The comparisons were made on a basis of average percentage difference in yield, average percentage error and frequency of errors greater than ±10%. The results of these comparisons are shown in Table 1.

Table 1.

Comparison of Weekly, Fortnightly, Monthly and Adjusted Monthly Milk Productions with Actual Milk Production.

Milk Production Recorded.	Av. Milk Yield. (lb.)	Av. Percentage Difference from Actual Production.	Av. Percentage Error (Disregarding (Sign).	Frequency of Errors Larger than ±10%.
Daily (Actual production) ..	4,164	—	—	—
Weekly	4,160	−0·24±1·37*	1·6	None
Fortnightly	4,164	+0·05±2·28	2·5	1 in 89
Monthly	4,007	−3·68±5·45	6·8	1 in 5
Monthly (Adjusted)	4,193	+0·39±3·10	3·9	1 in 32

* Standard error of the average percentage difference.

The range of difference from the actual milk production was as follows:—

Weekly	— 213 lb. to + 327 lb.
Fortnightly	— 418 lb. to + 363 lb.
Monthly	— 900 lb. to + 628 lb.
Adjusted monthly	— 477 lb. to + 445 lb.

Unfortunately, it was not possible to compare the butterfat production on all the lactations; only 53 records were available. Since the butterfat percentage was only calculated weekly, a comparison has been made of the butterfat production calculated on the basis of weekly weighing and testing and monthly weighing and testing.

The comparisons were made on a basis of variability, average percentage difference in yield, average percentage error and frequency of errors greater than ±10%. The relative variability of the estimations was calculated by the ratios of their mean squares. The results are summarised in Table 2.

Table 2.

Comparison of Monthly and Weekly Weighings and Tests for Butterfat Production.

—	Relative Variability of Records (percentage of weekly).	Av. Percentage Difference from Weekly Records.	Av. Percentage Error (Disregarding Sign).	Frequency of Error Larger than ±10%.
Butterfat Production (Monthly tests)	119·0	−5·5±7·89*	9·7	1 in 3
Butterfat Percentage (Monthly tests)	115·0	−0·7±3·97	4·6	1 in 9

* Standard error of the average percentage difference.

The average butterfat production per lactation based on monthly recording was 192 lb., while that based on a weekly recording was 202 lb. The average butterfat percentage for all cows for their whole lactations based on monthly recording was 4·72%, compared with 4·76% based on weekly recording. The range of differences for production based on monthly and weekly recordings was from — 64 lb. to + 32 lb. for butterfat production and from —0·91% to +0·48% for butterfat percentage.

The average difference between milk production based on monthly recording and actual milk production was highly significant. Average differences between adjusted monthly or fortnightly or weekly milk production and actual milk production were not significant. The difference between butterfat percentage based on monthly and weekly recordings was not significant, but the difference between butterfat production based on monthly and weekly recordings was highly significant.

DISCUSSION AND CONCLUSIONS.

It is evident that there may be a considerable discrepancy between estimated production based on monthly recording and actual production. On correcting for actual lactation length and recording intervals the discrepancy is lessened somewhat, but there is still a considerable error. Fortnightly recording lessens the discrepancy further, particularly with respect to the frequency of errors larger than ±10%, while weekly recording lessens it still further.

Recording at weekly intervals would be quite suitable for milk secretion studies, such as the effect of various methods of feeding on milk production and composition where small numbers of cows are involved. Where large numbers of cows are included in an experiment and the degree of expected response is greater than 10%, fortnightly recording should be quite satisfactory.

Monthly recording for milk and butterfat yield should not be condemned on this evidence; it is, notwithstanding, a most useful method of providing data for constructive breeding in dairy cattle. Its accuracy would be considerably enhanced in this regard if due consideration was given to reducing the variation in recording intervals, and if allowance was made for calving and drying-off dates.

(Received for publication May 4, 1954.)

IDENTIFICATION OF THE SPECIES OF FUSARIUM CAUSING WILT IN PASSION VINES IN QUEENSLAND.

By G. S. PURSS, B.Sc.Agr., Assistant Pathologist, Division of Plant Industry.

SUMMARY.

Cross-inoculation studies with various forms of Fusarium oxysporum **commonly found in Queensland were undertaken.**

The evidence indicates that Fusarium oxysporum **forma** passiflora **n.f. is the causal agent of wilt in the passion vine in Queensland.**

INTRODUCTION.

A wilt disease of the passion vine (*Passiflora edulis* Sims), in Queensland caused by a species of *Fusarium* was described by McKnight (1951) and the susceptibility of various species of *Passiflora* to this organism was determined.

A culture of the *Fusarium* was forwarded by courtesy of the Commonwealth Mycological Institute to Dr. W. L. Gordon, Laboratory of Plant Pathology, Winnipeg, Manitoba, who identified the organism as *Fusarium oxysporum* Schlecht. em Snyder and Hansen. He suggested that as the organism had proven pathogenic to mature passion vine it be referred to as *F. oxysporum* Schlecht. em Snyder and Hansen forma *passiflorae* n.f.

CROSS-INOCULATIONS.

Before release of this name cross-inoculation studies with other forms of *F. oxysporum* commonly found in Queensland were undertaken.

The following isolates were used:—

(1) *Fusarium* sp. obtained from wilted passion vines.

(2) *F. oxysporum* f. *lycopersici* (Sacc.) Snyder and Hansen obtained from wilted tomato plants.

(3) *F. oxysporum* f. *niveum* (E.F.S.) Snyder and Hansen obtained from wilted watermelon plants.

(4) *F. oxysporum* f. *pisi* (Lindf.) Snyder and Hansen obtained from wilted pea plants.

Cultures of these fungi were grown on potato-dextrose-agar for two weeks. Seedlings of tomato, watermelon, pea, and *Passiflora edulis* were inoculated with each of these cultures, using the water-fungus technique referred to by McKnight (1951). The passion fruit seedlings used were six weeks old, while those of the other species were three weeks old.

The results obtained are summarised in Table 1.

Table 1.

CROSS-INOCULATION OF VARIOUS PLANT SPECIES WITH FUSARIA.

Treatment.	Plant Species Inoculated.	Number of Plants.	After 15 days.	
			Healthy.	Wilting.
Uninoculated	*P. edulis*	4	4	0
	Tomato	5	5	0
	Pea	3	3	0
	Watermelon..	3	3	0
Fusarium sp. from passion vine. 10480	*P. edulis*	4	0	4
	Tomato	5	5	0
	Pea	4	4	0
	Watermelon..	5	5	0
F. oxysporum f. *lycopersici* 10529	*P. edulis*	4	4	0
	Tomato	5	0	5
	Pea	5	5	0
	Watermelon..	5	5	0
F. oxysporum f. *pisi* 10463 ..	*P. edulis*	4	4	0
	Tomato	5	5	0
	Pea	6	0	6
	Watermelon..	4	4	0
F. oxysporum f. *niveum* 10620	*P. edulis*	5	5	0
	Tomato	5	5	0
	Pea	4	4	0
	Watermelon..	4	0	4

A second series carried out on similar lines gave the same definite results.

McKnight had previously compared the tomato and passion vine Fusaria and obtained the same reactions as those indicated above.

The diseased plants of tomato, pea and watermelon showed typical symptoms of fusarium wilt. The leaves turned yellow and the plants wilted. Brown vascular discolouration was apparent in each case. The diseased passion fruit seedlings showed the typical seedling symptoms of fusarium wilt described by McKnight (1951).

CULTURAL CHARACTERISTICS.

In culture all organisms appeared somewhat similar. However, the substrate of the isolate of *F. oxysporum* f. *niveum* was of a much deeper red colouration than any of the other organisms. A potato-dextrose-agar culture of the *Fusarium* obtained from passion fruit has a distinctive fruity odour not noticeable with the other forms.

CONCLUSION.

These results indicate that the various isolates of *Fusarium* causing wilt of passion vine, pea, watermelon and tomato in Queensland are distinct forms.

On this evidence the name suggested by Dr. Gordon, *Fusarium oxysporum* Schlecht. em Snyder and Hansen forma *passiflorae* n.f., should be accepted as the name for the causal agent of wilt in the passion vine.

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(Received for publication April 27, 1954.)

A. H. Tucker, Government Printer, Brisbane.